Digital Elevation Models of Texas and West Louisiana Coast: Procedures, Data Sources, and Analysis

Amante, C.J., M.R. Love, M.R. Stiller, and K.S. Carignan

Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO
NOAA National Centers for Environmental Information, Boulder, CO

Summary

In March of 2021, NOAA's National Centers for Environmental Information (NCEI) developed integrated bathymetric–topographic digital elevation models (DEMs) according to specifications developed jointly by NOAA NCEI and the United States Geological Survey (USGS) to help better define a consistent elevation mapping framework for the nation (Table 1). Overall, 99 tiled DEMs were created in the area of interest: 82 tiles were created at the highest resolution of 1/9th arc-second and 17 were created at a resolution of 1/3rd arc-second. Only 1/9th arc-second DEM tiles integrate topography and bathymetry. The DEM tiles represent the most accurate publicly-available data at the time of their creation; the intent is to update specific tiles as new source data become available. The utilization of a tiling scheme in developing the DEMs is intended to improve data management during source data processing as well as facilitate targeted DEM updates.

The Texas and West Louisiana DEM tiles incorporates post-Hurricane Harvey topographic and bathymetric datasets from NOAA, USGS, U.S. Army Corps of Engineers (USACE), Natural Resources Conservation Service (NRCS), and Texas Water Development Board (TWDB) to support the Bipartisan Budget Act of 2018: NOAA Supplemental Funding for Hurricanes Harvey, Irma, and Maria. Additional DEM tiles were also developed in Texas and West Louisiana to support the Consumer Option for an Alternative System to Allocate Losses (COASTAL) Act. The tiled DEMs cover the Texas and West Louisiana coast between Victoria, Texas and Lafayette, Louisiana, which importantly includes the Houston, Texas region. The extents of these DEMs, procedures, data sources, and analysis are described below. The methodologies used by NCEI in developing DEMs are described in the NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018).

Table 1. Specifications for the DEM tiles.

Grid Area	Texas and West Louisiana Coast
Coverage Area	96.50° to 92.25° W, 28.00° to 30.75° N
Coordinate System	Geographic decimal degrees
Horizontal Datum	NAD 83
Vertical Datum	NAVD 88
Vertical Units	Meters
Cell Size	Variable (1/9th or 1/3rd Arc-Second)
Grid Format	Geotiff

DEM Specifications

The Texas and West Louisiana tiled DEMs were built to the specifications listed in Table 1. Figure 1 shows the 1/9th arc-second DEM tile boundaries in orange and the 1/3rd arc-second DEM tile boundaries in green.
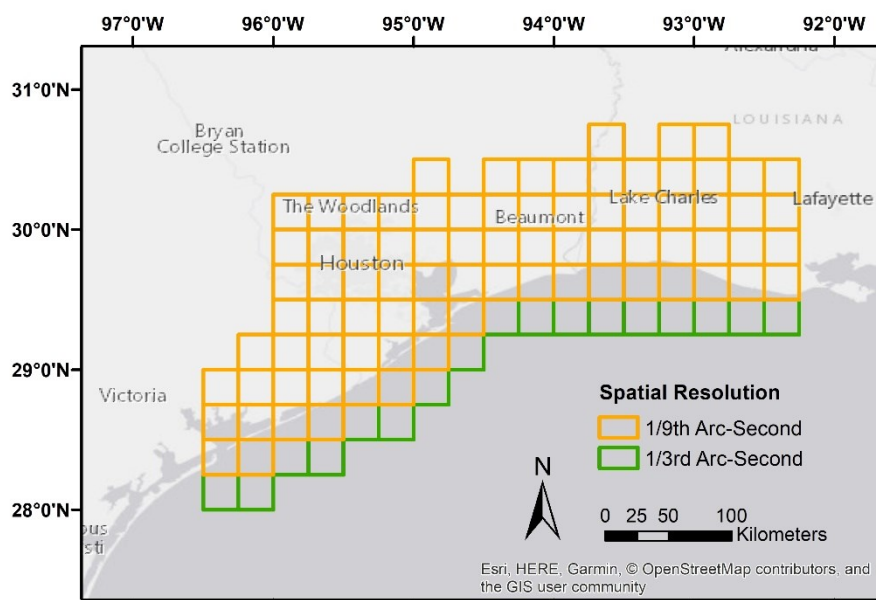

Figure 1. Map image of the DEM tile boundaries for the Texas and West Louisiana Coast DEMs.

Data Sources and Processing

Bathymetry data used in the generation of the Texas and West Louisiana Coast DEMs included NOAA National Ocean Service (NOS) hydrographic surveys and bathymetric attributed grids (BAGs), NOAA Office of Coast Survey (OCS) electronic navigational charts (ENCs), NCEI Digitized Soundings: Brazos River and Oyster Creek - NOAA RNC 11322, USACE hydrographic channel condition surveys, TWDB hydrographic

surveys, and International Hydrographic Organization's Data Centre for Digital Bathymetry (IHO DCDB) Crowdsourced Bathymetry (Table 2).

Table 2: Bathymetric data sources used in DEM development.

Source	Date	Date Type	Spatial Resolution	Horizontal Datum	Vertical Datum
NOAA NOS hydrographic surveys	1897 - 2009	XYZ	< 10 meters to several kilometers	NAD83	Mean lower low water (MLLW)
USACE hydrographic channel condition surveys	1999 - 2021	XYZ	~1 to 10 meters	NAD83	Mean lower low water (MLLW)
NOAA NOS hydrographic surveys: bathymetric attributed grids (BAGs)	2006 - 2020	BAGs	0.5 to 4 meters	NAD83	Mean lower low water (MLLW)
Texas Water Development Board (TWDB) hydrographic surveys	2010	XYZ	~75 to 150 meter spaced profiles	NAD83 - State Plane Texas South Central Zone (feet)	Varies -- NAVD88; NGVD29; MSL; Not Referenced
NCEI Digitized Soundings: Brazos River and Oyster Creek - NOAA RNC 11322	2017	XYZ	~3 meters	WGS84	Undefined
International Hydrographic Organization's Data Centre for Digital Bathymetry (IHO DCDB) Crowdsourced Bathymetry Files	2018 - 2020	XYZ	~1 to 20 meters	WGS84	Assumed instantaneous water level
NOAA OCS electronic navigational chart (ENC) extracted soundings	2019 - 2021	XYZ	< 10 meters to several kilometers	WGS84	Mean lower low water (MLLW)

NOAA NCEI multibeam bathymetric surveys were evaluated but not used in DEM development. With the exception of the TWDB hydrographic surveys, NCEI Digitized Soundings: Brazos River and Oyster Creek - NOAA RNC 11322, and International Hydrographic Organization's Data Centre for Digital Bathymetry (IHO

DCDB) Crowdsourced Bathymetry Files, bathymetric data were transformed from mean lower low water (MLLW) to NAVD88. Vertical datum transformations were performed using NOAA's VDatum Software. Where more recent, higher resolution data existed, older data were edited or superseded.

Bathymetric-topographic data used in developing the Texas and West Louisiana Coast DEMs included bathymetric-topographic lidar from NOAA National Geodetic Survey (NGS), USACE National Coastal Mapping Program (NCMP), and the University of Texas Bureau of Economic Geology (BEG; Table 3).

Table 3: Bathymetric-Topographic data sources used in DEM development.

Source	Date	Data Type	Spatial Resolution	Horizontal Datum	Vertical Datum
University of Texas Bureau of Economic Geology (BEG): Lower Texas Coast	2015	Topographic-bathymetric lidar	~1 to 3 meter	NAD83	NAVD88
USACE NCMP Topobathy Lidar: Gulf Coast (AL, FL, MS, TX)	2016	Topographic-bathymetric lidar	~1 to 3 meter	NAD83	NAVD88
NOAA NGS Topobathy Lidar Post Hurricane Harvey: Galveston to Corpus Christi TX	2018 - 2019	Topographic-bathymetric lidar	~1 to 3 meter	NAD83	NAVD88

Topographic data used in developing the Texas and West Louisiana Coast DEMs included lidar data from the USGS, TWDB, and Texas Natural Resources Information System (TNRIS; Table 4).

Table 4: Topographic data sources used in DEM development.

Source	Date	Data Type	Spatial Resolution	Horizontal Datum	Vertical Datum
TWDB Lidar: Calhoun County	2006	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
USGS 2010-2011 ARRA Lidar: Calhoun County (TX)	2010 - 2011	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
USGS Lidar Point Cloud TX Neches	2016	Topographic lidar	~1 to 3 meter	UTM Zone 15N NAD83 (NSRS2011)	NAVD88
USGS Lidar: Chenier Plain LA	2017	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
TNRIS Lidar: Jefferson Liberty and Chambers TX (East)	2017	Topographic lidar	~0.5 meter	NAD83	NAVD88
TNRIS Lidar: Jefferson Liberty and Chambers TX (West)	2017	Topographic lidar	~0.5 meter	NAD83	NAVD88
USGS Lidar Point Cloud TX East	2017	Topographic lidar	~1 to 3 meter	UTM Zone 15N NAD83 (NSRS2011)	NAVD88
USGS Lidar Point Cloud LA Sabine River	2018	Topographic lidar	~1 to 3 meter	UTM Zone 15N NAD83	NAVD88

					(NSRS2011)	
USGS Lidar: South Texas	2018	Topographic lidar	~1 to 3 meter	NAD83	NAVD88	
TWDB Lidar: Coastal Texas	2018	Topographic lidar	~0.5 meter	NAD83	NAVD88	
USGS Lidar: Matagorda Bay TX	2018	Topographic lidar	~1 to 3 meter	NAD83	NAVD88	
USGS Lidar: Bayou Nezpique LA	2018	Topographic lidar	~1 to 3 meter	NAD83	NAVD88	
USGS Lidar Point Cloud TX Red River Lavaca Wharton	2018	Topographic lidar	~1 to 3 meter	UTM Zone 14N NAD83 (NSRS2011)	NAVD88	
USGS Lidar Point Cloud TX Hurricane Supplemental DRRA	2018	Topographic lidar	~1 to 3 meter	UTM Zone 14N/15N NAD83 (NSRS2011)	NAVD88	
USGS Lidar Point Cloud TX Eastern	2018	Topographic lidar	~1 to 3 meter	UTM Zone 14N/15N NAD83 (NSRS2011)	NAVD88	

DEM Development

Development of the Texas and West Louisiana Coast DEM tiles followed procedures documented in NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018). Exceptions being that the bathymetric pre-surface was generated at 1 arc-second due to the coarse resolution of offshore bathymetric data, and gridding weights were modified as shown in Table 5. The bathymetric pre-surface derived from data sources in Tables 2 and 3 was converted to XYZ and was utilized in the final DEM creation. Older, coarse, and/or inaccurate bathymetric surveys from NOAA NOS hydrographic surveys, NOAA OCS electronic navigational chart (ENC) extracted soundings, NCEI Digitized Soundings: Brazos River and Oyster Creek - NOAA RNC 11322, and International Hydrographic Organization's Data Centre for Digital Bathymetry (IHO DCDB) Crowdsourced Bathymetry Files were used in the bathymetric pre-surface generation but were not used as source datasets in the final DEM creation with MB-System's 'mbgrid.' Two additional interpolated datasets derived from the USACE hydrographic channel condition surveys and the Texas Water Development Board Hydrographic Surveys were also included in the bathymetric pre-surface generation and final DEM creation. The purpose of these additional datasets were to guide interpolation between sparse channel conditional survey profiles and more realistically represent the dredged channels and Lake Houston, respectively.

Table 5: Data hierarchy used to assign gridding weights in MB-System's 'mbgrid.'

Dataset	Relative Gridding Weight
NOAA NGS Topobathy Lidar Post Hurricane Harvey: Galveston to Corpus Christi TX	10000
USGS Lidar: South Texas	1000
USGS Lidar Point Cloud TX Red River Lavaca Wharton	1000
TWDB Lidar: Coastal Texas	1000
USGS Lidar: Matagorda Bay TX	1000
TNRIS Lidar: Jefferson Liberty and Chambers TX (East)	1000
TNRIS Lidar: Jefferson Liberty and Chambers TX (West)	1000
USGS Lidar: Bayou Nezpique LA	1000
USGS Lidar Point Cloud TX Red River Lavaca Wharton	1000
USGS Lidar Point Cloud TX Hurricane Supplemental DRRA	1000
USGS Lidar Point Cloud TX Eastern	1000
USGS Lidar Point Cloud TX East	1000
USGS Lidar Point Cloud TX Neches	1000
USGS Lidar Point Cloud LA Sabine River	1000
USACE NCMP Topobathy Lidar: Gulf Coast (AL, FL, MS, TX)	100
Univ of TX BEG Topobathy Lidar: Lower Texas Coast	10
USACE hydrographic channel condition surveys	10
NOAA NOS hydrographic surveys: bathymetric attributed grids (BAGs)	10
USGS 2010-2011 ARRA Lidar: Calhoun County (TX)	1
TWDB Lidar: Calhoun County	1
Interpolated USACE hydrographic channel condition surveys	0.1
Texas Water Development Board Hydrographic Surveys	0.000001
Interpolated Texas Water Development Board Hydrographic Surveys	0.000001
Bathymetric pre-surface	0.000001

DEM Analysis

Once the Texas and West Louisiana Coast DEMs were generated, the DEMs were compared to the high-resolution source elevation data and high-resolution imagery. Inconsistencies were evaluated and resolved based on the most reliable data available. The largest outstanding issues with the DEM tiles are the lack of publicly-available lidar and sonar in coastal marsh lands and bayous in Eastern Texas and Western Louisiana. When higher-resolution, publicly available data becomes available for these areas, these DEM tiles will be updated with more accurate, detailed elevation and depth information.

References

C.J. Amante (2018) NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida, NOAA, pp. 6.
https://www.ngdc.noaa.gov/mgg/dat/dems/tiled_tr/east_florida_tiled_navd88_2018.pdf